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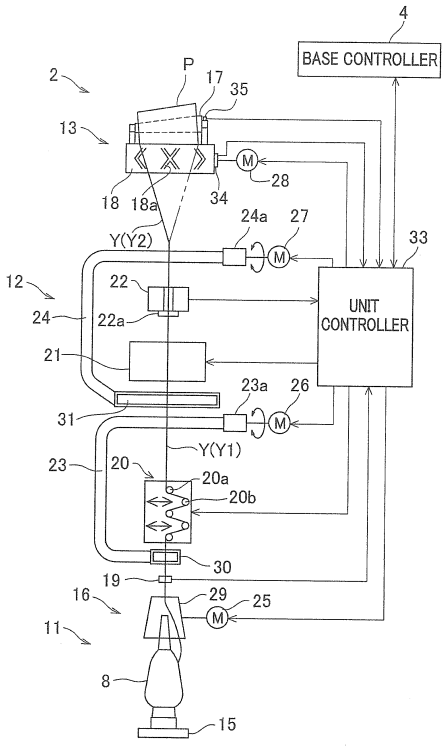
(54) YARN WINDING DEVICE, TEXTILE MACHINE, AND PACKAGE FORMING METHOD

(57) An object is to reliably prevent a yarn from being loosely wound on a package, while reducing the possibility that the operation of catching a yarn end portion takes a long time. When a signal indicating the absence of the running yarn (Y) is output from a yarn clearer (22) or from a yarn feeler (19) during formation of the package (P), a unit controller (33) controls a winding portion (13) to keep rotating the package (P) for a predetermined continuous rotation period while increasing the rotation speed of the package (P).

FIG.2



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Description

Technical Field

[0001] The present invention relates to a technique of winding a running yarn to form a package.

Background Art

[0002] Patent Literature 1 discloses a yarn winding apparatus, specifically, a winding unit of an automatic winder configured to rewind a yarn pulled out from a yarn supplying bobbin to form a package. The winding unit includes a yarn joining device configured to join a yarn end portion on a winding package side with a yarn end portion on a yarn supplying bobbin side when the state of absence of the running yarn is established due to yarn breakage, yarn cut, or the like. The winding unit includes: a suction mouth configured to suck and catch the yarn end portion on the winding package side and to guide the yarn end portion to the yarn joining device; and a suction pipe configured to suck and catch the yarn end portion on the yarn supplying bobbin side and to guide the yarn end portion to the yarn joining device.

[0003] When the yarn breakage or the like occurs, the rotation of the package is stopped. At this time, the yarn end portion on the package side is wound on the package due to inertial rotation of the package. For this reason, the package is rotated in the direction opposite to a winding direction, which is the rotation direction of the package for winding the yarn, with the suction mouth located close to the surface of the package. With this, the yarn end portion is pulled out from the package, to be sucked and caught by the suction mouth.

[0004] Patent Literature 1 also refers to the case where the yarn breakage or the like occurs while the rotation of the package is accelerated. Because the rotation speed of the package is still low during the acceleration of the package, the yarn is more likely to be loosely wound on the package to form a slack portion of the yarn if the package is stopped when the yarn breakage or the like occurs. If the slack portion is formed, the suction mouth may unintentionally suck the slack portion, which is an intermediate portion of the yarn, instead of the end portion of the yarn. To the above problem, Patent Literature 1 takes the following measures: when the yarn breakage or the like occurs during the acceleration of the package, the rotation of the package is stopped once, and after the suction mouth is brought close to the package, the package is rotated again in the winding direction for a predetermined period of time (e.g., within 2 seconds). With this, the package is rotated in the winding direction while the slack portion of the yarn is sucked by the suction mouth. As a result, the slack portion of the yarn is properly rewound, and thus, the slack portion is removed.

Citation List

Patent Literature

[0005] Patent Literature 1: Japanese Unexamined Patent Publication No. 2007-302457

Summary of Invention

Technical Problem

[0006] In Patent Literature 1, when the yarn breakage or the like occurs during the formation of the package, the rotation of the package is stopped once, and then the package is rotated in the winding direction to rewind the yarn. Thereafter, the package is rotated in the opposite direction to pull out the yarn end portion. Thus, extra time is needed for the process of stopping the package once and the process of resuming the rotation in the winding direction. As a result, the time required for catching the yarn end portion becomes longer correspondingly.

[0007] In addition, if the suction mouth brought close to the package successfully sucks and holds the slack portion of the yarn after the package is stopped once, the slack portion of the yarn is removed by rotating the package thereafter in the winding direction. However, the suction mouth does not always suck the slack portion of the yarn. If the suction mouth fails to suck the slack portion of the yarn, the slack portion is not held, and therefore it is difficult to remove the slack portion of the yarn by rotating the package thereafter in the winding direction.

[0008] An object of the present invention is to reliably prevent a yarn from being loosely wound on a package, while reducing the possibility that the operation of catching a yarn end portion takes a long time.

Solution to Problem and Advantageous Effects of Invention

[0009] According to a first aspect of the invention, a yarn winding apparatus includes: a winding portion configured to wind a running yarn to form a package; a yarn running signal output unit configured to output a signal related to running of the yarn; and a controller configured to control the winding portion, wherein: winding of the package is stopped when output of a signal indicating presence of the running yarn from the yarn running signal output unit is stopped during formation of the package, or when a signal indicating absence of the running yarn is output from the yarn running signal output unit during the formation of the package; and when the output of the signal indicating the presence of the running yarn is stopped or when the signal indicating the absence of the running yarn is output, the controller is capable of performing acceleration continuation control of controlling the winding portion to keep rotating the package for a predetermined continuous rotation period while increasing the rotation speed of the package, and then stopping

the winding of the package.

[0010] In this aspect, when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit, due to an occurrence of yarn breakage or the like, the package is not stopped but is kept rotating while the rotation speed of the package is increased, and then winding of the package is stopped. Hereinafter, the above-described series of control processes is referred to as acceleration continuation control. In this acceleration continuation control, when the state of the absence of the running yarn is established, the rotation of the package is kept, and the rotation speed of the package is increased. As a result, the yarn is tightly wound on the package, and this prevents the yarn from being loosely wound on the package. Further, because the speed of the rotation is increased without stopping the rotation of the package, the period of time required for catching a yarn end portion is shorter than in the case where the rotation of the package is stopped once and then resumed.

[0011] Note that the state of the absence of the running yarn in the present invention can be established not only when yarn breakage occurs, but also when the yarn is compulsorily cut upon detection of a defect in the yarn, and when the yarn of a yarn supplying portion to be supplied to the winding portion is exhausted. Hereinafter, the phenomena and operations which cause the state of the absence of the running yarn, such as the yarn breakage, yarn cut, and exhaustion of the yarn in the yarn supplying portion, are collectively referred to as "yarn breakage or the like".

[0012] According to the second aspect of the invention, the yarn winding apparatus of the first aspect is arranged such that when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped during an acceleration period in which the rotation speed of the package increases, or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit during the acceleration period, the controller performs the acceleration continuation control.

[0013] In the acceleration period before the rotation speed of the package reaches a predetermined speed, the rotation speed of the package is low, and therefore it is more likely that the yarn is slack if yarn breakage or the like occurs during the acceleration period. Thus, in this aspect, the rotation speed of the package is increased when the state of the absence of the running yarn is established during the above acceleration period. This effectively prevents the yarn from being loosely wound on the package. Meanwhile, after the acceleration period passes, i.e., after the rotation speed of the package reaches the predetermined speed, the speed of the package is not increased even though the yarn breakage or the like occurs. This prevents the operation of catching the yarn end portion from taking unnecessarily long time.

[0014] According to the third aspect of the invention, the yarn winding apparatus of the second aspect is arranged such that when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped during a low-speed period in the acceleration period, or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit during the low-speed period in the acceleration period, the controller performs the acceleration continuation control.

[0015] Particularly in the low-speed period in the acceleration period, the rotation speed of the package has not been sufficiently increased yet, and therefore it is more likely that the yarn is slack if yarn breakage or the like occurs during the low-speed period. Thus, in this aspect, the rotation speed of the package is increased when the state of the absence of the running yarn is established during the low-speed period, which is the initial stage of the acceleration and has the highest probability of forming the slack in the yarn. This effectively prevents the yarn from being loosely wound on the package. Meanwhile, after the low-speed period passes, the speed of the package is not increased even if the state of the absence of the running yarn is established. This prevents the operation of catching the yarn end portion from taking unnecessarily long time.

[0016] According to the fourth aspect of the invention, the yarn winding apparatus of the second or third aspect further includes a tension applying unit configured to apply tension to the running yarn, and the apparatus is arranged such that the controller controls the tension applying unit so that the tension applied to the yarn during the acceleration period is lower than the tension applied to the yarn after the acceleration period passes.

[0017] If the yarn breakage or the like occurs under the condition that the tension applied to the yarn is high, the yarn end portion is more likely to leap, and therefore the yarn is more likely to be loosely wound on the package. In this aspect, the tension applied to the yarn during the acceleration period is lower than the tension applied to the yarn after the acceleration period passes, and this makes it less likely that the yarn leaps when the yarn breakage or the like occurs during the acceleration period in which the rotation speed of the package is low. This makes it less likely that the yarn is loosely wound on the package.

[0018] According to the fifth aspect of the invention, the yarn winding apparatus of any one of the first to fourth aspects further includes a first setting unit through which the continuous rotation period in the acceleration continuation control is settable.

[0019] The longer the continuous rotation period during which the rotation speed of the package increases is, the less likely it is that the yarn is slack when the yarn breakage or the like occurs. However, if the continuous rotation period exceeds a predetermined length, the time required for catching the yarn is unnecessarily long. Further, the length of the continuous rotation period with

which the slack of the yarn is prevented differs depending on the yarn type, winding conditions, and the like. In this aspect, in accordance with the yarn type, winding conditions, and/or the like, the optimum length of the continuous rotation period is settable through the first setting unit.

[0020] According to the sixth aspect, the yarn winding apparatus of the fifth aspect is arranged such that the continuous rotation period is settable through the first setting unit using at least one of parameters: time, the rotation speed of the package, and yarn running speed.

[0021] Through the first setting unit, the continuous rotation period is settable using time, the rotation speed of the package, or the yarn running speed. The proper use of at least one of these parameters facilitates optimum setting of the continuous rotation period, in accordance with the yarn type, winding conditions, and/or the like.

[0022] According to the seventh aspect of the invention, the yarn winding apparatus of the sixth aspect is arranged such that the time length of the continuous rotation period is set, through the first setting unit, to be not less than 0.5 seconds and less than 10 seconds.

[0023] In this aspect, the time length of the continuous rotation period is not less than 0.5 seconds, and this enables the yarn to be tightly wound on the package during the continuous rotation period, to prevent the slack of the yarn. Meanwhile, the time length of the continuous rotation period is less than 10 seconds, and therefore the period of time required for the operation of catching the yarn end portion is not unnecessarily long.

[0024] According to the eighth aspect of the invention, the yarn winding apparatus of to any one of fifth to seventh aspects is arranged such that the continuous rotation period is settable, through the first setting unit, in accordance with the winding diameter of the package.

[0025] The larger the diameter of the package is, the more likely it is that the yarn is loosely wound on the package. For this reason, it is preferable to increase the length of the continuous rotation period with the increase in the diameter. In this aspect, the continuous rotation period is set to have a proper length, in accordance with the winding diameter of the package.

[0026] According to the ninth aspect of the invention, the yarn winding apparatus of the third aspect further includes a second setting unit through which the low-speed period is settable.

[0027] The longer the low-speed period is, the less likely it is that the yarn is slack due to the yarn breakage or the like. However, if the low-speed period is too long, the package might be accelerated also in the case where the yarn cannot be slack under some winding condition or the like. In this case, the time required for catching the yarn end portion is unnecessarily long. The threshold of the rotation speed of the package, below which the acceleration of the package is needed when the yarn breakage or the like occurs, varies depending on the yarn type, winding conditions, and the like. In this aspect, in accordance with the yarn type, winding conditions, and/or the like, the optimum length of the low-speed period is settable through the second setting unit.

[0028] According to the tenth aspect of the invention, the yarn winding apparatus of the ninth aspect is arranged such that the low-speed period is settable through the second setting unit using at least one of parameters: time, the rotation speed of the package, and yarn running speed.

[0029] Through the second setting unit, the low-speed period is settable using time, the rotation speed of the package, or the yarn running speed. The proper use of at least one of these parameters facilitates optimum setting of the low-speed period, in accordance with the yarn type, winding conditions, and/or the like.

[0030] According to the eleventh aspect of the invention, the yarn winding apparatus of any one of the first to tenth aspects further includes a first yarn end catcher configured to suck and catch a yarn end portion on a winding portion side from the package when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit, and the apparatus is arranged such that the controller controls the first yarn end catcher to start operation of catching the yarn end portion during the continuous rotation period in the acceleration continuation control.

[0031] In this aspect, the first yarn end catcher starts the operation of catching the yarn end portion while the package is accelerated to wind the yarn in the continuous rotation period, and this shortens the time required for catching the yarn end portion. The package may be accelerated while the yarn end portion is held using the suction force of the first yarn end catcher applied to the yarn end portion. In this arrangement, the yarn is further tightly wound on the package.

[0032] According to the twelfth aspect of the invention, the yarn winding apparatus of any one of the first to tenth aspects further includes a first yarn end catcher configured to suck and catch a yarn end portion on a winding portion side from the package when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit, and the apparatus is arranged such that the controller controls the first yarn end catcher to start operation of catching the yarn end portion after the continuous rotation period in the acceleration continuation control elapses.

[0033] In this aspect, the catching operation by the first yarn end catcher is started after the package is accelerated during the continuous rotation period to tightly wind the yarn on the package, and therefore no slack portion of the yarn is caught by the first yarn end catcher.

[0034] According to the thirteenth aspect of the invention, the yarn winding apparatus includes: a yarn supplying portion configured to supply yarns; a second yarn end catcher configured to catch a yarn end portion on a yarn supplying portion side when the output of the signal in-

dicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit; and a yarn joining portion provided between the yarn supplying portion and the winding portion, the yarn joining portion being configured to join the yarn end portion on the winding portion side with the yarn end portion on the yarn supplying portion side, wherein the first yarn end catcher guides the caught yarn end portion on the winding portion side to the yarn joining portion, and the second yarn end catcher guides the caught yarn end portion on the yarn supplying portion side to the yarn joining portion.

[0035] In the yarn joining portion, after the yarn end portion on the winding portion side and the yarn end portion on the yarn supplying portion side are joined together, unnecessary parts from the joint to the respective ends are cut off. If the slack portion of the yarn on the winding portion side is caught by the first yarn end catcher, a part of the yarn from the slack portion to the yarn end portion, which should have been caught, is cut off in the yarn joining portion. The thus cut part functions as lint, which may be involved in the package. In this regard, generation of such lint is prevented in this aspect.

[0036] According to the fourteenth aspect of the invention, a textile machine includes: a plurality of yarn winding apparatuses each recited in any one of the fifth to eighth aspects; and a central controller configured to control the plurality of yarn winding apparatuses. The first setting unit, through which the continuous rotation period in the acceleration continuation control for each of the yarn winding apparatuses is set, is provided to the central controller.

[0037] In this aspect, it is possible to collectively set the continuous rotation periods of the plurality of yarn winding apparatuses through the first setting units provided to the central controller.

[0038] According to the fifteenth aspect, a method for forming a package by winding, in a winding portion, a yarn supplied from a yarn supplying portion includes the step of, when a state of absence of the yarn running from the yarn supplying portion to the winding portion is established during formation of the package, keeping rotation of the package for a predetermined continuous rotation period while increasing the rotation speed of the package, and then stopping winding of the package.

[0039] In this aspect, when the state of the absence of the running yarn from the yarn supplying portion to the winding portion is established, the package is kept rotating without stopping the package, while the rotation speed of the package is increased, and then winding of the package is stopped. As such, the rotation of the package is kept while the rotation speed of the package is increased, and thereby, the yarn is tightly wound onto the package. This prevents yarn from being loosely wound onto the package. Further, because the speed is increased without stopping the rotation of the package, the operation for catching the yarn end portion does not take a long time.

[0040] According to the sixteenth aspect of the invention, the method of the fifteenth aspect is arranged such that when the state of the absence of the running yarn from the yarn supplying portion to the winding portion is established during an acceleration period in which the rotation speed of the package increases, the rotation of the package is kept for the predetermined continuous rotation period while the rotation speed of the package is increased.

[0041] In this aspect, when the state of the absence of the running yarn from the yarn supplying portion to the winding portion is established during the acceleration period of the package, the rotation speed of the package is increased. This effectively prevents the yarn from being loosely wound on the package.

[0042] According to the seventeenth aspect, the method of the fifteenth or sixteenth aspect is arranged such that the continuous rotation period is set using at least one of parameters: time, the rotation speed of the package, and yarn running speed.

[0043] In this aspect, the proper use of at least one of the three parameters (time, the rotation speed of the package, and yarn running speed) facilitates optimum setting of the continuous rotation period, in accordance with the yarn type, winding conditions, and/or the like.

Brief Description of Drawings

[0044]

[FIG. 1] FIG. 1 is a front elevation of an automatic winder of the present embodiment.

[FIG. 2] FIG. 2 is a front elevation of a winding unit of the automatic winder.

[FIG. 3] FIG. 3 is a left side view of the winding unit of the FIG. 2.

[FIG. 4] FIG. 4 is a flowchart illustrating a yarn joining process.

[FIG. 5] FIG. 5 is an enlarged view of a winding portion at the time of catching an end portion of a yarn by a suction mouth.

[FIG. 6] FIG. 6 includes graphs each showing the change in the rotation speed of a package as a function of time.

[FIG. 7] FIG. 7 is a graph showing the change in the yarn running speed as a function of time.

[FIG. 8] FIG. 8 includes graphs each showing the change in the rotation speed of the package as a function of time, in a modification.

[FIG. 9] FIG. 9 is a graph showing the change in the rotation speed of the package as a function of time, in another modification.

[FIG. 10] FIG. 10 is a graph showing the change in the rotation speed of the package as a function of time, in still another modification.

Description of Embodiments

[0045] The following will describe an embodiment of the present invention. The following embodiment is one embodiment of the present invention, in which the present invention is applied to an automatic winder, a sort of textile machines. FIG. 1 is a front elevation of the automatic winder of the present embodiment. FIG. 2 is a front elevation of a winding unit of the automatic winder.

[0046] As shown in FIG. 1, an automatic winder 1 includes: a large number of winding units 2 (yarn winding apparatuses) arranged in the left-right direction of FIG. 1; a doffing device 3 provided to be able to travel along the large number of winding units 2 in an arrangement direction of the winding units 2; and a base controller 4 configured to perform overall control of the automatic winder 1. The following description will be given using the terms for directions defined as follows: the left-right direction in FIG. 1 (the arrangement direction of the winding units 2) is defined as a "left-right direction". Further, out of the directions perpendicular to the sheet of FIG. 1, the direction toward a viewer of FIG. 1 is defined as "frontward", and the direction away from the viewer of FIG. 1 is defined as "backward".

[0047] The automatic winder 1 is structured so that: the base controller 4 gives a command to each winding unit 2; and in each winding unit 2, a yarn Y unwound from a yarn supplying bobbin 8 is wound on a take up tube 17 to form a package P. When a full package P is formed in one of the winding units 2, the doffing device 3 is moved to a position above the winding unit 2 having the full package P, to replace the full package P with an empty take up tube 17. The base controller 4 (central controller) is configured to control the operation of each winding unit 2, and to perform other operations such as monitoring of the operation state, and setting and storing of operational parameters. As shown in FIG. 1, the base controller 4 is provided with an operation setting unit 5 and a display 6. Through the operation setting unit 5, various settings related to the winding units 2 and the doffing device 3 are feasible.

[0048] Now, the detailed structure of each winding unit 2 will be described. The winding unit 2 shown in FIG. 2 is configured to wind, on the take up tube 17, the yarn Y unwound from the yarn supplying bobbin 8, while traversing the yarn Y, to form the package P of a predetermined shape. FIG. 3 is a left side view of the winding unit 2 shown in FIG. 2.

[0049] As shown in FIG. 2, the winding unit 2 includes: a yarn supplying portion 11 which supports the yarn Y on the yarn supplying bobbin 8 so as to be unwindable; a yarn processor 12 configured to carry out various processes on the yarn Y supplied from the yarn supplying portion 11; and a winding portion 13 configured to wind the yarn Y processed in the yarn processor 12 on the take up tube 17, to form the package P. The yarn supplying portion 11, the yarn processor 12, and the winding portion 13 are arranged in this order from bottom to top. The winding unit 2 includes a unit controller 33 communicably connected to the base controller 4 of the automatic winder 1.

[0050] The yarn supplying portion 11 includes: a bobbin holder 15 which holds the yarn supplying bobbin 8; and an unwinding assist unit 16 which assists unwinding of the yarn Y from the yarn supplying bobbin 8. The unwinding assist unit 16 includes: a cylinder body 29 with which the yarn supplying bobbin 8 is covered from above; and a cylinder body drive motor 25 for moving the cylinder body 29 upward and downward. The cylinder body 29 is lowered by the cylinder body drive motor 25 as the unwinding of the yarn Y proceeds, and thereby, the unwinding assist unit 16 restrains the balloon of the unwound yarn Y, to stabilize unwinding tension.

[0051] As shown in FIG. 2 and FIG. 3, the winding portion 13 includes: a cradle 14 which holds the take up tube 17 so as to be rotatable; a traversing drum 18; and a drum drive motor 28 configured to rotate the traversing drum 18. On the periphery of the traversing drum 18, a spiral traversing groove 18a is formed. With this traversing groove 18a, the yarn Y is traversed. The traversing drum 18 rotates in contact with the package P formed on the take up tube 17 while traversing the yarn Y held in the spiral traversing groove 18a. By the thus created contact friction with the traversing drum 18, the package P is rotated in the winding direction, with the result that the yarn Y unwound from the yarn supplying bobbin 8 is wound on the take up tube 17. The winding portion 13 further includes: a drum rotation sensor 34 configured to detect the rotation speed of the traversing drum 18; and a package rotation sensor 35 configured to detect the rotation speed of the package P.

[0052] The yarn processor 12 provided between the yarn supplying portion 11 and the winding portion 13 includes: a yarn feeler 19; a tension applying device 20; a yarn joining device 21; and a yarn clearer 22.

[0053] The yarn feeler 19 is provided between the unwinding assist unit 16 and the tension applying device 20, and is configured to detect the presence or absence of the running yarn Y.

[0054] The tension applying device 20 is configured to apply predetermined tension to the running yarn Y. In FIG. 2, the device of a so-called gate type is illustrated, by way of example. Fixed gate members 20a and movable gate members 20b are alternately arranged in an up-down direction. By adjusting the horizontal positions of the movable gate members 20b, tension is applied to the yarn Y running through the fixed gate members 20a and the movable gate members 20b.

[0055] The yarn joining device 21 (yarn joining portion) is configured to join a lower yarn Y1 on a yarn supplying bobbin 8 side with an upper yarn Y2 on a package P side in the state of the absence of the yarn Y running between the yarn supplying portion 11 and the winding portion 13. This state is established, for example, when the yarn Y is cut by a cutter 22a after the yarn clearer 22 detects a yarn defect (which will be described later), when yarn

breakage occurs during winding of the package P, and when the yarn supplying bobbin 8 is replaced with a new one.

[0056] Below the yarn joining device 21, there is provided a lower yarn catch guide member 23 configured to catch the lower yarn Y1 on the yarn supplying bobbin 8 side and to guide the lower yarn Y1 to the yarn joining device 21. Above the yarn joining device 21, there is provided an upper yarn catch guide member 24 configured to catch the upper yarn Y2 on the package P side and to guide the upper yarn Y2 to the yarn joining device 21. The lower yarn catch guide member 23 is rotatable about an axis 23a, and is configured to rotate upward and downward when driven by a motor 26. The upper yarn catch guide member 24 is also rotatable about an axis 24a, and is configured to rotate upward and downward when driven by a motor 27. Further, as shown in FIG. 3, the lower yarn catch guide member 23 and the upper yarn catch guide member 24 are connected to a sucking power source 50.

[0057] The lower yarn catch guide member 23 has, at its leading end portion, a sucker 30 configured to suck an end portion of the lower yarn Y1 to catch the end portion. While the end portion of the lower yarn Y1 is caught by the sucker 30, the lower yarn catch guide member 23 is driven by the motor 26 to rotate upward, thereby to guide the lower yarn Y1 to the yarn joining device 21. The lower yarn catch guide member 23 and the motor 26 which rotates the lower yarn catch guide member 23 correspond to a "second yarn end catcher" in the present invention.

[0058] The upper yarn catch guide member 24 has, at its leading end portion, a suction mouth 31 configured to suck an end portion of the upper yarn Y2 to catch the end portion. The upper yarn catch guide member 24 at the position illustrated with solid lines in FIG. 3 is first driven by the motor 27 to rotate upward to a yarn end catch position illustrated with two-dot chain lines in FIG. 3. With this, the suction mouth 31 is positioned near a contact point between the package P and the traversing drum 18, and the suction mouth 31 sucks the end portion of the upper yarn Y2 attached to the surface of the package P, to catch the end portion. After catching the end portion, the upper yarn catch guide member 24 is driven by the motor 27 to rotate downward, thereby to guide the thus caught upper yarn Y2 to the yarn joining device 21. The upper yarn catch guide member 24 and the motor 27 which rotates the upper yarn catch guide member 24 correspond to a "first yarn end catcher" in the present invention.

[0059] The yarn joining device 21 is configured to join the end portion of the lower yarn Y1 guided by the lower yarn catch guide member 23 with the end portion of the upper yarn Y2 guided by the upper yarn catch guide member 24, into the single yarn Y. As the yarn joining device 21, an air splicer may be used, which is configured to untwist the end portions of the two yarns and then to intertwine the end portions together, with the use of turbulent air flow. Unnecessary parts formed as a result of joining the end portions of the two yarns, i.e., the parts of the yarns from the joint to the respective leading ends, are cut off by an unillustrated cutter incorporated in the yarn joining device 21.

[0060] The yarn clearer 22 constantly acquires information on the thickness of the running yarn Y. Based on the information on the yarn thickness, the yarn clearer 22 regards, as a yarn defect, an abnormal part of the yarn Y which has a thickness larger than a predetermined threshold. Thus, the yarn defect is detected. Further, the yarn clearer 22 is provided with the cutter 22a. When the yarn clearer 22 detects a yarn defect, the cutter 22a immediately cuts the yarn Y.

[0061] Note that, after the yarn clearer 22 detects a yarn defect and then the yarn Y is cut by the cutter 22a in this way, the upper yarn Y2 still has the yarn defect. For this reason, the yarn joining device 21 joins the lower yarn Y1 and the upper yarn Y2 together after removing the yarn defect from the upper yarn Y2, which has been guided by the upper yarn catch guide member 24, using an unillustrated cutter incorporated in the yarn joining device 21.

[0062] The unit controller 33 (controller) shown in FIG. 2 is configured to control the operation of each part of the winding unit 2 such as the winding portion 13 and the yarn joining device 21 as described above, so as to form the package P on the take up tube 17. The unit controller 33 is structured by: a central processing unit (CPU); a read-only memory (ROM) in which a program executed by the CPU and data used for the program are stored; a random access memory (RAM) for temporally storing data at the time of execution of the program; and an input/output interface through which data is input from/output to the outside.

[0063] The unit controller 33 is electrically connected to the drive units in the winding unit 2, such as the cylinder body drive motor 25, the motor 26 for driving the lower yarn catch guide member 23, the motor 27 for driving the upper yarn catch guide member 24, and the drum drive motor 28. The unit controller 33 is further electrically connected to the yarn feeler 19, the tension applying device 20, the yarn joining device 21, the yarn clearer 22, the drum rotation sensor 34, the package rotation sensor 35, and the like. The unit controller 33 controls each part of the winding unit 2 based on information on winding conditions and the like transmitted from the base controller 4, which controls the overall operation of the automatic winder 1, so that the winding unit 2 performs operation of forming the package P.

[0064] Now, a description is given for the joining process of the lower yarn Y1 with the upper yarn Y2 by the yarn joining device 21. FIG. 4 is a flowchart illustrating the yarn joining process. Note that Si (i = 1, 2, 3...) in FIG. 4 refers to the step number. FIG. 5 is an enlarged view of the winding portion at the time of catching the yarn end portion by the suction mouth 31. When the supply of the yarn Y from the yarn supplying portion 11 is stopped and

the absence of the yarn Y running between the yarn supplying portion 11 and the winding portion 13 is detected, the unit controller 33 controls the yarn joining device 21 and the like to execute the yarn joining process shown in FIG. 4.

(1) Detection of the absence of the running yarn

[0065] The absence of the running yarn Y is detected in the following manner. First, when a yarn defect is detected by the yarn clearer 22, the yarn Y is cut by the cutter 22a provided in the yarn clearer 22. Based on a yarn defect detection signal transmitted from the yarn clearer 22, the unit controller 33 determines that the state of the absence of the running yarn Y has been established. Alternatively, the unit controller 33 may determine that the state of the absence of the running yarn Y has been established based on a signal from the yarn feeler 19, because the yarn feeler 19 no longer detects the yarn Y after the yarn Y is cut by the cutter 22a.

[0066] The state of the absence of the running yarn Y is also established when yarn breakage occurs between the yarn supplying portion 11 and the winding portion 13, or when the yarn supplying bobbin 8 is replaced with a new one in the yarn supplying portion 11. When the state of the absence of the running yarn Y is detected by the yarn clearer 22, the yarn clearer 22 transmits, to the unit controller 33, a signal indicating the absence of the running yarn. Alternatively, output of a signal indicating the presence of the running yarn is stopped, i.e., the signal which has been output from the yarn clearer 22 is no longer output. That is, in the present embodiment, the yarn clearer 22 corresponds to a yarn running signal output unit configured to output a signal related to running of the yarn Y. Instead of the yarn clearer 22, the yarn feeler 19 may detect the yarn breakage. For the sake of convenience, hereinafter, the phenomena and operations which cause the state of the absence of the running yarn, such as the yarn breakage, yarn cut, and replacement of the yarn supplying bobbin 8, are collectively referred to as "yarn breakage or the like".

(2) Prevention of yarn slack after yarn breakage

[0067] If the rotation of the package P is suddenly stopped immediately after the occurrence of yarn breakage or the like, a slack portion Yb may be formed, as indicated with a two-dot chain line in FIG. 5. The slack portion Yb is a portion of the upper yarn Y2 loosely wound on the package P. Particularly, when the yarn breakage or the like occurs under the condition that the rotation speed of the package P is low, it is more likely that the yarn Y is loosely wound around the package P, to form the slack portion Yb. The above condition is created, for example, when the yarn breakage or the like occurs immediately after winding of the package P is resumed subsequently to yarn joining by the yarn joining device 21.

[0068] If, instead of the yarn end portion Ya of the upper yarn Y2, the intermediate slack portion Yb is unintentionally sucked and caught by the suction mouth in this state, two yarn parts forming the slack portion Yb are guided to the yarn joining device 21 (this is referred to as "double pullout"). In this case, the slack portion Yb of the upper yarn Y2 and the yarn end portion of the lower yarn Y1 are joined together by the yarn joining device 21, resulting in a yarn joining anomaly. Meanwhile, after the upper yarn Y2 and the lower yarn Y1 are joined together, the unnecessary parts from the joint to the respective ends are cut off by the unillustrated cutter in the yarn joining device 21. If the slack portion Yb of the upper yarn Y2 is caught by the suction mouth 31 and the slack portion Yb is joined with the lower yarn Y1, a part of the upper yarn Y2 from the slack portion Yb to the yarn end portion Ya, which should have been caught, is cut off by the cutter in the yarn joining device 21. The thus cut part functions as lint, which may be involved in the package P.

[0069] In view of the above, in the present embodiment, when the yarn breakage or the like occurs soon after the start of the winding of the yarn Y under the condition that the rotation speed of the package P is low, the rotation of the package P is kept while the rotation speed of the package P is increased in order to tightly wind the upper yarn Y2 onto the package P.

[0070] FIG. 6 includes graphs each showing the change in the rotation speed of the package P as a function of time. FIG. 6(a) shows the change in the rotation speed of the package P in a normal winding process. As shown in FIG. 6(a), at the start of the winding of the yarn Y, the unit controller 33 controls the drum drive motor 28 of the winding portion 13 to start the rotation of the traversing drum 18, thereby starting the rotation of the package P. The rotation speed of the package P increases at a predetermined acceleration rate during an acceleration period TA which is the period before the rotation speed reaches a predetermined speed VA. After the acceleration period TA elapses, i.e., when the rotation speed of the package P reaches the speed VA, the unit controller 33 controls the drum drive motor 28 so as to rotate the traversing drum 18 at a constant speed. As a result, the package P rotates at a substantially constant speed (VA).

[0071] Strictly speaking, while the traversing drum 18 rotates at a constant speed, constant is the peripheral speed of the package P. The winding diameter of the package P increases as the winding of the yarn Y proceeds. Because of this, in actual, the rotation speed of the package P is not constant from the start to the end of the winding of the package P, but the rotation speed of the package P gradually decreases with the increase in the winding diameter. However, FIG. 6(a) shows nothing more than a part of the whole process of forming the package P, and therefore the rotation speed of the package P is regarded as the constant speed VA.

[0072] FIG. 6(b) to FIG. 6(d) each shows the change in the rotation speed of the package P for the case where the yarn breakage or the like occurs. The filled circle Pc on each of the graphs of FIG. 6(b) to FIG. 6(d) represents

the timing at which the yarn breakage or the like occurs.

[0073] FIG. 6(b) shows the change in the rotation speed of the package P for the case where the yarn breakage or the like occurs during the normal winding period. As shown in FIG. 6(b), when the yarn breakage or the like occurs at a timing T1 during the normal winding period in which the package P rotates at the speed VA, the upper yarn Y2 wound on the package P is less likely to be slack even if the rotation of the package P is stopped immediately, because the rotation speed of the package P is sufficiently high. For this reason, in the yarn joining process shown in FIG. 4, when the yarn breakage or the like occurs after the acceleration of the package P is completed (S 1: No), the unit controller 33 controls the drum drive motor 28 to stop the rotation of the package P (S4).

[0074] FIG. 6(c) shows the change in the rotation speed of the package P for the case where the yarn breakage or the like occurs during a high-speed period in the acceleration period. As shown in FIG. 6(c), the yarn breakage or the like occurs during the acceleration period in which the rotation speed of the package P is increasing, but it occurs at a timing T2 within the high-speed period which is the period after the rotation speed exceeds an intermediate speed VB. In this case, the upper yarn Y2 wound on the package P is less likely to be slack even if the rotation of the package P is stopped immediately. For this reason, in the yarn joining process shown in FIG. 4, when the yarn breakage or the like occurs during the acceleration period of the package P, and the yarn breakage or the like occurs during the high-speed period in the acceleration period (S2: No), the unit controller 33 controls the drum drive motor 28 to stop the rotation of the package P (S4).

[0075] FIG. 6(d) shows the change in the rotation speed of the package P for the case where the yarn breakage or the like occurs during a low-speed period in the acceleration period. Suppose, as shown in FIG. 6(d), the yarn breakage or the like occurs during the acceleration period in which the rotation speed of the package P is increasing, and it occurs at a timing T3 during the low-speed period in the acceleration period. The low-speed period is the period before the rotation speed reaches the intermediate speed VB. Because the yarn breakage or the like occurs before the rotation speed of the package P has sufficiently increased, it is more likely that the upper yarn Y2 is loosely wound on the package P to form the slack portion Yb if the rotation of the package P is immediately stopped at this timing.

[0076] For this reason, in the yarn joining process shown in FIG. 4, when the yarn breakage or the like occurs during the acceleration period of the package P and when it occurs during the low-speed period in the acceleration period (S1: Yes, and S2: Yes), the unit controller 33 performs the following acceleration continuation control. First, the unit controller 33 controls the drum drive motor 28 to keep the rotation (forward rotation) of the package P in the winding direction (forward rotation) for a predetermined continuous rotation period (period Ta in FIG. 6(d)), without stopping the package P, while increasing the rotation speed of the package P in the winding direction (S3). Then, the winding of the package P is stopped (S4). In FIG. 6(d), the acceleration rate of the rotation of the package P (inclination of the line in FIG. 6(d)) in the continuous rotation period is identical with the acceleration rate of the package P in the period before the detection of the yarn breakage or the like. After the continuous rotation period passes, the unit controller 33 stops the rotation of the package P (S4).

[0077] As such, the package P is kept rotating with acceleration during the predetermined continuous rotation period immediately after the detection of the yarn breakage or the like. This prevents the upper yarn Y2 from being loosely wound onto the package P because the upper yarn Y2 is tightly wound onto the package P.

[0078] The low-speed period and the high-speed period in the acceleration period are settable by an operator through the operation setting unit 5 (corresponding to a second setting unit of the present invention) provided to the base controller (see FIG. 1). The longer the low-speed period is, the less likely it is that the upper yarn Y2 is slack due to the yarn breakage or the like. However, if the low-speed period is too long, the package P might be accelerated also in the case where the upper yarn Y2 cannot be slacked under some winding condition or the like. In this case, the time required for catching the yarn end portion Ya is unnecessarily long. The threshold of the rotation speed of the package P, below which the accelerated rotation of the package P is needed when the yarn breakage or the like occurs, varies depending on the yarn type, winding conditions, and the like. Thus, in the present embodiment, the optimum lengths of the low-speed period and the high-speed period in the acceleration period are settable by the operator through the operation setting unit 5, in accordance with the yarn type, winding conditions, and/or the like.

[0079] Through the operation setting unit 5, the above periods are settable using at least one of the following parameters: time, the winding speed of the package P, and the yarn running speed.

[0080] When using time for the setting, a timing TB in FIG. 6 is set. In this case, the period from the start of the rotation of the package P to the timing TB in the acceleration period is the low-speed period, and the period from the timing TB to the timing TA in the acceleration period is the high-speed period. The unit controller 33 incorporates therein a timer to measure the time having elapsed from the start of the rotation of the package P. Thus, on the basis of the time measured by the timer, the unit controller 33 is able to determine the state of the package P at the time of occurrence of the yarn breakage or the like.

[0081] When using the winding speed of the package P for the setting, the winding speed VB of the package P in FIG. 6 is set. In this case, the period before the rotation speed of the package P reaches VB in the acceleration period is the low-speed period, and the period

after the rotation speed of the package P reaches VB and before the rotation speed reaches VA in the acceleration period is the high-speed period. The actual rotation speed of the package P is detected by the package rotation sensor 35. Thus, on the basis of a signal from the package rotation sensor 35, the unit controller 33 is able to determine the state of the package P at the time of occurrence of the yarn breakage or the like.

[0082] Because the yarn running speed changes with the change in the rotation speed of the package P, the low-speed period and the high-speed period of the package P are settable using the yarn running speed. FIG. 7 is a graph showing the change in the yarn running speed as a function of time. When using the yarn running speed, a yarn running speed VB' in FIG. 7 corresponding to the intermediate speed VB of the package P in FIG. 6 is set. Since the yarn running speed is equal to the peripheral speed of the package P, the yarn running speed is obtainable from the rotation speed of the traversing drum 18 detected by the drum rotation sensor 34. Thus, on the basis of a detection signal from the drum rotation sensor 34, the unit controller 33 is able to determine the state of the package P at the time of occurrence of the yarn breakage or the like.

[0083] The low-speed period and the high-speed period in the acceleration period may be settable through the operation setting unit 5 using two or more of the three parameters: time, the winding speed of the package P, and the yarn running speed. For example, through the operation setting unit 5, both the parameters of time (TA, TB) and the speed (VA, VB) in FIG. 6 may be set.

[0084] In addition to the above, the continuous rotation period, which is the period during which the accelerated rotation in the forward direction is kept after the yarn breakage or the like occurs, is also settable by the operator, as well as the low-speed period and the high-speed period in the acceleration period. The continuous rotation period is settable through the operation setting unit 5 (corresponding to a first setting unit in the present invention) provided to the base controller 4 (see FIG. 1), in accordance with the yarn type, winding conditions, and/or the like. Similarly to the acceleration period, the continuous rotation period is also settable using at least one of the parameters: time, the winding speed of the package P, and the yarn running speed.

[0085] When using time for the setting, the period Ta in FIG. 6(d) is set. In this case, after the yarn breakage or the like is detected, the unit controller 33 keeps rotating the package P for the period Ta while accelerating the package P at the acceleration rate which is the same as that before the detection of the yarn breakage or the like. When using the winding speed of the package P for the setting, a speed VC in FIG. 6(d) is set. In this case, the unit controller 33 keeps rotating the package P until the speed reaches the speed VC while accelerating the package P at the acceleration rate which is the same as that before the detection of the yarn breakage or the like. When using the yarn running speed for the setting, a speed VC' in FIG. 7 is set. In this case, the unit controller 33 keeps rotating the package P until the yarn running speed reaches the speed VC' while accelerating the package P to increase the yarn running speed at the acceleration rate which is the same as that before the detection of the yarn breakage or the like.

[0086] In the case where the continuous rotation period is set using the winding speed of the package P or the yarn running speed, the target speed at which the continuous rotation period ends may be set by incrementing the speed at the time when the yarn breakage or the like occurs by a predetermined rate. For example, if the increment rate of the speed is set to 10%, the accelerated rotation in the forward direction is kept until the speed reaches the value obtained by incrementing the speed at the time of detection of the yarn breakage or the like by 10%.

[0087] Similarly to the setting for the above-described low-speed period and the high-speed period, the continuous rotation period may be settable through the operation setting unit 5 using two or more of the three parameters: time, the winding speed of the package P, and the yarn running speed. For example, both the period Ta and the speed VC in FIG. 6 may be settable through the operation setting unit 5.

[0088] The longer the continuous rotation period is, the less likely it is that the slack of the yarn is caused when the yarn breakage or the like occurs. It is preferable that the time length of the continuous rotation period is not less than 0.5 seconds, for example. However, if the continuous rotation period is long more than necessary, delay is caused in the following processes. This unnecessarily prolongs the period of time required for the suction mouth 31 to catch the yarn end portion Ya, and eventually, prolongs the period of time required for the overall yarn joining operation. In view of the above, it is preferable that the time length of the continuous rotation period is less than 10 seconds. Further, the length of the continuous rotation period with which the slack of the upper yarn Y2 is prevented differs depending on the yarn type, winding conditions, and the like. Thus, the operator sets the optimum length of the continuous rotation period using at least one of the above three parameters, through the operation setting unit 5, in accordance with the yarn type, winding conditions, and/or the like.

[0089] The larger the diameter of the package P is, the more likely it is that the upper yarn Y2 is loosely wound on the package P. For this reason, it is preferable that the length of the continuous rotation period is increased with the increase in the diameter. Therefore, the continuous rotation period is settable through the operation setting unit 5, in accordance with the winding diameter of the package P. For example, the operator sets, through the operation setting unit 5, a plurality of lengths of the continuous rotation period respectively corresponding to a plurality of winding diameters of the package P. Meanwhile, in the present embodiment, the unit controller 33 is capable of obtaining the winding diameter of the pack-

age P. For example, by counting the total number of rotations of the traversing drum 28 from the start of the winding of the package P using the drum rotation sensor 34, it is possible to estimate the amount of the yarn wound on the package P, i.e., the winding diameter of the package P. Upon occurrence of the yarn breakage or the like, the unit controller 33 selects the length of the continuous rotation period corresponding to the winding diameter of the package P at this timing.

(3) Operation of catching yarn end portion

[0090] The sucker 30 provided at the leading end portion of the lower yarn catch guide member 23 in FIG. 2 is on standby at a lower position (the position below the tension applying device 20, as shown in FIG. 2) during the winding of the package P. Therefore, when the yarn breakage or the like occurs, the lower yarn Y1 is immediately caught by the sucker 30 of the lower yarn catch guide member 23.

[0091] Meanwhile, the unit controller 33 controls the upper yarn catch guide member 24 to start the operation of catching the yarn end portion Ya of the upper yarn Y2 (S5). That is, the unit controller 33 controls the motor 27 to rotate the upper yarn catch guide member 24 upward. Then, as shown in FIG. 3, the suction mouth 31 at the leading end portion of the upper yarn catch guide member 24 is brought close to the surface of the package P.

[0092] Further, the unit controller 33 controls the drum drive motor 28 to rotate the package P in an unwinding direction which is opposite to the winding direction (reverse rotation), to pull out the yarn end portion Ya wound on the package P (S6). The thus pulled out yarn end portion Ya is sucked and caught by the suction mouth 31. If the rotation speed of the package P at the time of occurrence of the yarn breakage or the like is low, the accelerated rotation of S3 is performed, and with this, the yarn is tightly wound on the package P to prevent the formation of the slack portion Yb. For this reason, no slack portion Yb is caught by the suction mouth 31.

[0093] In FIG. 4, after the package P is rotated in the forward direction with acceleration for the predetermined continuous rotation period in S3, i.e., after the continuous rotation period ends, the unit controller 33 starts the catching operation by the suction mouth 31 (the rotation of the upper yarn catch guide member 24). In this arrangement, the catching operation by the suction mouth 31 is started after the package P is accelerated for the continuous rotation period to tightly wind the upper yarn Y2 on the package P, and therefore no slack portion Yb of the upper yarn Y2 is caught by the suction mouth 31.

[0094] Alternatively, the unit controller 33 may start the catching operation by the suction mouth 31 during the continuous rotation period in S3. In this arrangement, the period of time required for catching the yarn end portion Ya is shortened. The package P may be rotated in the forward direction while the yarn end portion Ya is held using the suction force of the suction mouth 31 applied to the yarn end portion Ya. In this arrangement, the upper yarn Y2 is further tightly wound on the package P.

[0095] The unit controller 33 controls the motor 27 to rotate the upper yarn catch guide member 24 downward, thereby to guide the yarn end portion of the upper yarn Y2 caught by the suction mouth 31 to the yarn joining device 21. Then, the unit controller 33 controls the motor 26 to rotate the lower yarn catch guide member 23 upward, thereby to guide the yarn end portion of the lower yarn Y1 caught by the sucker 30 to the yarn joining device 21.

(4) Yarn joining operation

[0096] Finally, the unit controller 33 controls the yarn joining device 21 to join the yarn end portion of the lower yarn Y1 guided by the lower yarn catch guide member 23 with the yarn end portion of the upper yarn Y2 guided by the upper yarn catch guide member 24 (S7).

[0097] As described above, in the present embodiment, when the yarn breakage or the like occurs to establish the state of the absence of the running yarn Y, the package P is kept rotating without being stopped while the rotation speed of the package P is increased. Thus, when the state of the absence of the running yarn Y is established, the rotation of the package P is kept, and the rotation speed of the package P is increased. With this, the upper yarn Y2 after the yarn breakage or the like is tightly wound on the package P, to prevent the upper yarn Y2 from being loosely wound on the package P. Further, because the speed of the rotation of the package P is increased without stopping the rotation of the package P, the operation of catching the yarn end portion Ya of the upper yarn Y2 does not take long time, and eventually, the overall yarn joining operation does not take long time.

[0098] If the slack portion Yb is caught and this double pullout yarn is joined with the lower yarn, lint is generated as a result of cutting of the unnecessary parts of the yarns in the yarn joining device 21. The lint may be involved in the package P. In this regard, the generation of such lint is prevented in the present embodiment.

[0099] The lower the rotation speed of the package P is, the more likely it is that the upper yarn Y2 is loosely wound on the package P when the yarn breakage or the like occurs. In the present embodiment, when the yarn breakage or the like occurs during the acceleration period of the package P, and particularly, only during the low-speed period in the acceleration period, the acceleration rotation of the package P is performed. This effectively prevents the upper yarn Y2 from being loosely wound on the package P. Meanwhile, when the rotation speed of the package P is higher than a predetermined speed, the package P is not accelerated even if the yarn breakage or the like occurs. This prevents the operation of catching the yarn end portion Ya from taking unnecessarily long time.

[0100] The low-speed period in the acceleration period

based on which it is determined whether the acceleration rotation of the package P is performed, and the continuous rotation period for which the acceleration rotation of the package P is performed are settable through the operation setting unit 5. This enables the low-speed period and the continuous rotation period to be set optimally in accordance with the yarn type, winding conditions, and/or the like. Further, the above periods are settable using time, the rotation speed of the package P, or the yarn running speed. The proper use of at least one of these parameters facilitates the optimum setting of these periods in accordance with the yarn type, winding conditions and/or the like. Furthermore, the operation setting unit 5 is provided to the base controller 4 of the automatic winder 1. This enables the operator to collectively set the above periods for the plurality of the winding units 2 through the operation setting unit 5.

[0101] Now, various modifications of the present embodiment will be described. It should be noted that the components having the same structures as those in the above-described embodiment are given the same reference numerals, and the description thereof will be given as needed.

1] In the above-described embodiment, as shown in FIG. 6 and FIG. 7, the acceleration rate of the rotation of the package P (or the acceleration rate of the running speed of the yarn) during the acceleration rotation of the package P which is performed after the detection of the yarn breakage or the like is set to be identical with the acceleration rate before the detection of the yarn breakage or the like. However, the acceleration before the detection of the yarn breakage or the like does not have to be identical with the acceleration rate after the detection.

For example, as shown in FIG. 8(a), the acceleration rate may be set so that the acceleration rate of the forward rotation of the package P after the detection of the yarn breakage or the like is higher than that before the detection of the yarn breakage or the like. To the contrary, as shown in FIG. 8(b), the acceleration rate may be set so that the acceleration rate of the forward rotation of the package P after the detection of the yarn breakage or the like is lower than that before the detection of the yarn breakage or the like.

2] In the above-described embodiment, the acceleration rotation of the package P in the forward direction is performed only when the yarn breakage or the like occurs in the acceleration period, specifically, during the low-speed period in the acceleration period. However, as shown in FIG. 9, the acceleration rotation of the package P may be performed not only when the yarn breakage or the like occurs during the low-speed period, but also when the yarn breakage or the like occurs during the high-speed period in the acceleration period. The modification shown in FIG. 9 is the same as the above-described embodiment in that the acceleration rotation of the package P is not performed when the yarn breakage or the like occurs in the normal winding period, i.e., the period after the rotation speed of the package P reaches the predetermined speed VA.

During the acceleration period of the package P, the rotation speed of the package P is lower than that in the normal winding period, and therefore the upper yarn Y2 is more likely to be slack if the yarn breakage or the like occurs. Thus, the rotation speed of the package P is increased when the yarn breakage or the like occurs during the acceleration period in which the slack portion Yb is more likely to be formed in the upper yarn Y2, and thereby to effectively prevent the upper yarn Y2 from being loosely wound on the package P.

3] If the yarn breakage or the like occurs under the condition that the tension of the yarn Y to be wound on the package P is high, the yarn end portion Ya is more likely to leap, and therefore the upper yarn Y2 is more likely to be loosely wound on the package P. It is therefore preferable that the tension applied to the yarn Y by the tension applying device 20 (tension applying unit) is set to be low in the acceleration period of the package P in which the upper yarn Y2 is more likely to be slack if the yarn breakage or the like occurs. That is to say, the unit controller 33 may be configured to control the tension applying device 20 so that the tension applied to the yarn Y during the acceleration period is lower than the tension applied to the yarn Y during the normal winding period after the acceleration period. With this, if the yarn breakage or the like occurs during the acceleration period in which the rotation speed of the package P is low, the tension of the yarn Y immediately before the breakage is low, which makes the yarn end portion Ya to be less likely to leap, and therefore the upper yarn Y2 is less likely to be loosely wound on the package P.

4] As shown in FIG. 10, the acceleration rotation of the package P may be performed when the yarn breakage or the like occurs during the normal winding period in which the package P is rotated at the predetermined speed VA, in addition to the case where the yarn breakage or the like occurs during the acceleration period in which the rotation speed of the package P increases. In this modification, irrespective of the acceleration of the package P, the acceleration rotation of the package P is always performed after the yarn breakage or the like occurs. This reliably prevents the upper yarn Y2 from being loosely wound on the package P.

5] In the above-described embodiment, the yarn Y to be wound on the package P is traversed by the traversing drum 18 having the spiral traversing groove 18a formed thereon. However, another type of traversing device may be used, such as arm type, belt type, and rotary type traversing devices.

Instead of using the drum type traversing device, a contact roller which does not have a spiral traversing groove may be provided so as to contact the package P. In this arrangement, the package P may be rotated by driving and rotating the above contact roller, in the same way as the traversing drum 18 of the above-described embodiment. Alternatively, package P may be rotated directly by a package drive motor provided, for example, to the cradle 14. In this arrangement, the contact roller is a driven roller which is rotated with the rotation of the package P.

6] The above-described embodiment deals with the case in which the present invention is applied to the automatic winder by way of example. The present invention is applicable not only to the above-described automatic winder, but also to other yarn winding apparatuses such as a winding machine and a spinning machine, including an air spinning machine and an open-end spinning machine, for example.

Reference Signs List

[0102]

1:	automatic winder
2:	winding unit
4:	base controller
5:	operation setting unit
11:	yarn supplying portion
13:	winding portion
19:	yarn feeler
20:	tension applying device
21:	yarn joining device
22:	yarn clearer
23:	lower yarn catch guide member
24:	upper yarn catch guide member
28:	drum drive motor
31:	suction mouth
33:	unit controller
P:	package
Y:	yarn
Y2:	upper yarn
Ya:	yarn end portion

Claims

1. A yarn winding apparatus comprising:

a winding portion configured to wind a running yarn to form a package;
a yarn running signal output unit configured to output a signal related to running of the yarn; and
a controller configured to control the winding portion, wherein:

winding of the package is stopped when output of a signal indicating presence of the running yarn from the yarn running signal output unit is stopped during formation of the package, or when a signal indicating absence of the running yarn is output from the yarn running signal output unit during the formation of the package; and
when the output of the signal indicating the presence of the running yarn is stopped or when the signal indicating the absence of the running yarn is output, the controller is capable of performing acceleration continuation control of controlling the winding portion to keep rotating the package for a predetermined continuous rotation period while increasing the rotation speed of the package, and then stopping the winding of the package.

2. The yarn winding apparatus according to claim 1, wherein when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped during an acceleration period in which the rotation speed of the package increases, or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit during the acceleration period, the controller performs the acceleration continuation control.

3. The yarn winding apparatus according to claim 2, wherein when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped during a low-speed period in the acceleration period, or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit during the low-speed period in the acceleration period, the controller performs the acceleration continuation control.

4. The yarn winding apparatus according to claim 2 or 3, further comprising a tension applying unit configured to apply tension to the running yarn, wherein the controller controls the tension applying unit so that the tension applied to the yarn during the acceleration period is lower than the tension applied to the yarn after the acceleration period passes.

5. The yarn winding apparatus according to any one of claims 1 to 4, further comprising a first setting unit through which the continuous rotation period in the acceleration continuation control is settable.

6. The yarn winding apparatus according to claim 5, wherein the continuous rotation period is settable through the first setting unit using at least one of parameters: time, the rotation speed of the package,

and yarn running speed.

7. The yarn winding apparatus according to claim 6, wherein the time length of the continuous rotation period is set, through the first setting unit, to be not less than 0.5 seconds and less than 10 seconds.

8. The yarn winding apparatus according to any one of claims 5 to 7, wherein the continuous rotation period is settable, through the first setting unit, in accordance with the winding diameter of the package.

9. The yarn winding apparatus according to claim 3, further comprising a second setting unit through which the low-speed period is settable.

10. The yarn winding apparatus according to claim 9, wherein the low-speed period is settable through the second setting unit using at least one of parameters: time, the rotation speed of the package, and yarn running speed.

11. The yarn winding apparatus according to any one of claims 1 to 10, further comprising a first yarn end catcher configured to suck and catch a yarn end portion on a winding portion side from the package when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit, wherein
the controller controls the first yarn end catcher to start operation of catching the yarn end portion during the continuous rotation period in the acceleration continuation control.

12. The yarn winding apparatus according to any one of claims 1 to 10, further comprising a first yarn end catcher configured to suck and catch a yarn end portion on a winding portion side from the package when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit, wherein
the controller controls the first yarn end catcher to start operation of catching the yarn end portion after the continuous rotation period in the acceleration continuation control elapses.

13. The yarn winding apparatus according to claim 11 or 12, further comprising:

a yarn supplying portion configured to supply yarns;
a second yarn end catcher configured to catch a yarn end portion on a yarn supplying portion side when the output of the signal indicating the presence of the running yarn from the yarn running signal output unit is stopped or when the signal indicating the absence of the running yarn is output from the yarn running signal output unit; and
a yarn joining portion provided between the yarn supplying portion and the winding portion, the yarn joining portion being configured to join the yarn end portion on the winding portion side with the yarn end portion on the yarn supplying portion side,

wherein
the first yarn end catcher guides the caught yarn end portion on the winding portion side to the yarn joining portion, and the second yarn end catcher guides the caught yarn end portion on the yarn supplying portion side to the yarn joining portion.

14. A textile machine comprising:

a plurality of yarn winding apparatuses each recited in any one of claims 5 to 8; and
a central controller configured to control the plurality of yarn winding apparatuses,

wherein
the first setting unit, through which the continuous rotation period in the acceleration continuation control for each of the yarn winding apparatuses is set, is provided to the central controller.

15. A method for forming a package by winding, in a winding portion, a yarn supplied from a yarn supplying portion, the method comprising the step of, when a state of absence of the yarn running from the yarn supplying portion to the winding portion is established during formation of the package, keeping rotation of the package for a predetermined continuous rotation period while increasing the rotation speed of the package, and then stopping winding of the package.

16. The method according to claim 15, wherein when the state of the absence of the running yarn from the yarn supplying portion to the winding portion is established during an acceleration period in which the rotation speed of the package increases, the rotation of the package is kept for the predetermined continuous rotation period while the rotation speed of the package is increased.

17. The method according to claim 15 or 16, wherein the continuous rotation period is set using at least one of parameters: time, the rotation speed of the package, and yarn running speed.

FIG.1

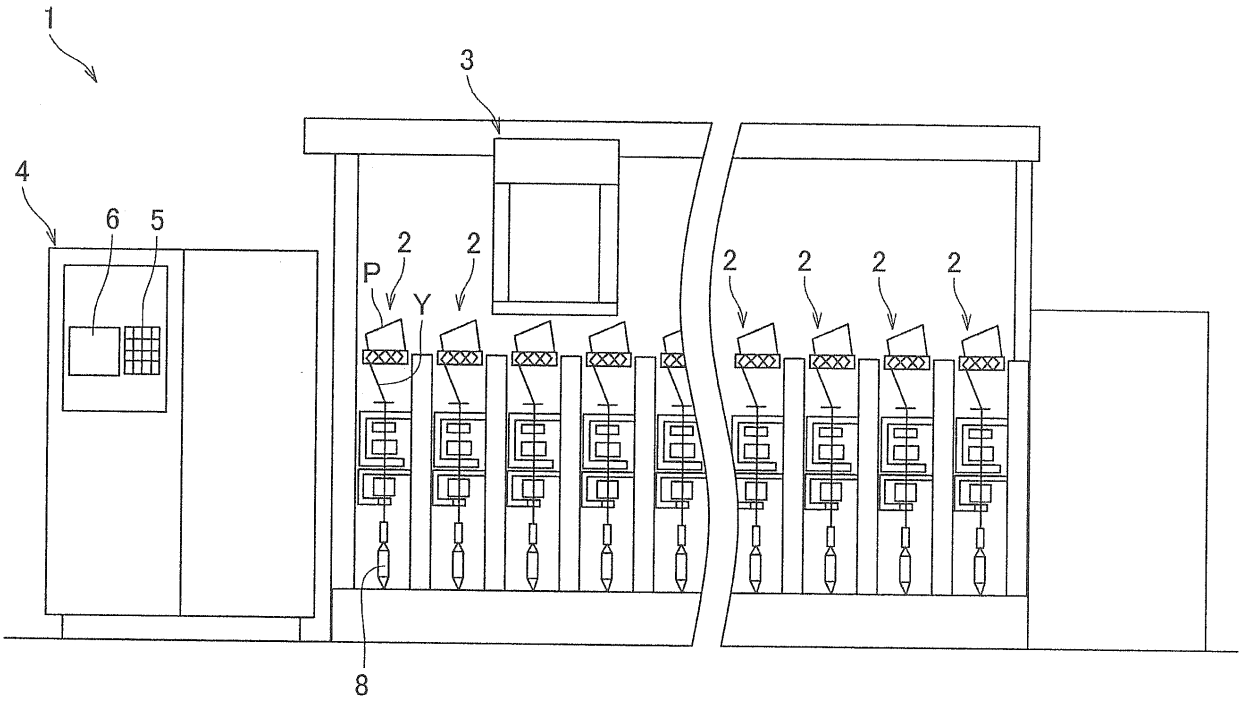


FIG.2

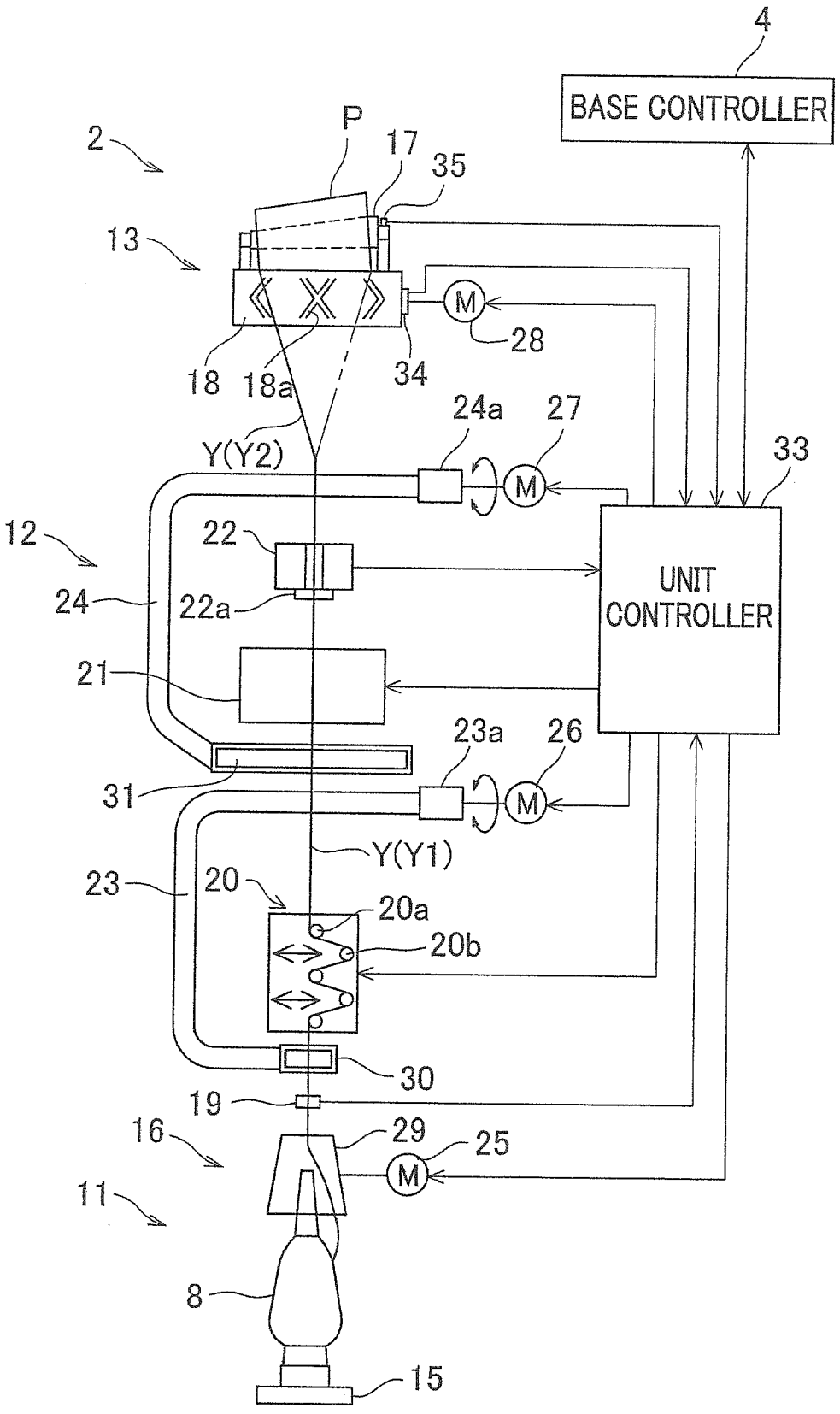

4
BASE CONTROLLER
P
17
35
2
13
M
28
18
18a
34
24a
27
Y(Y2)
33
12
22
UNIT
CONTROLLER
24
22a
21
23a
26
31
M
Y(Y1)
23
20
20a
20b
30
19
16
29
25
M
11
8
15

FIG.3

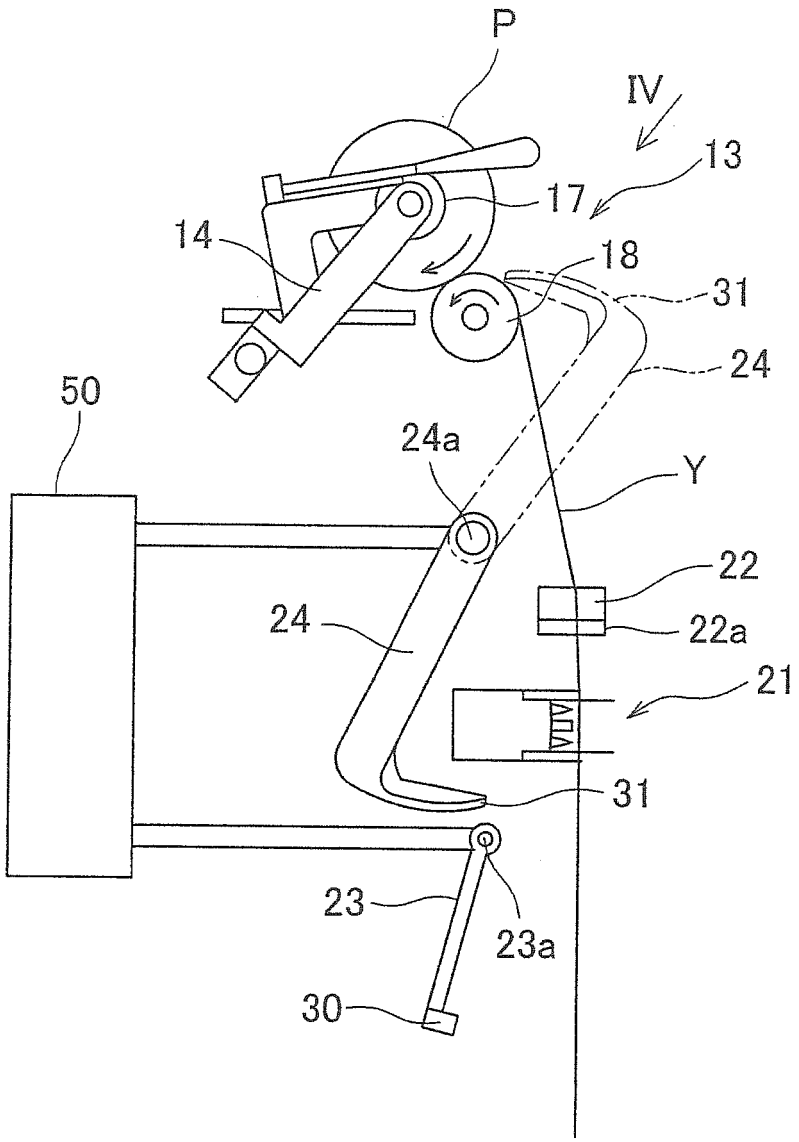


FIG.4

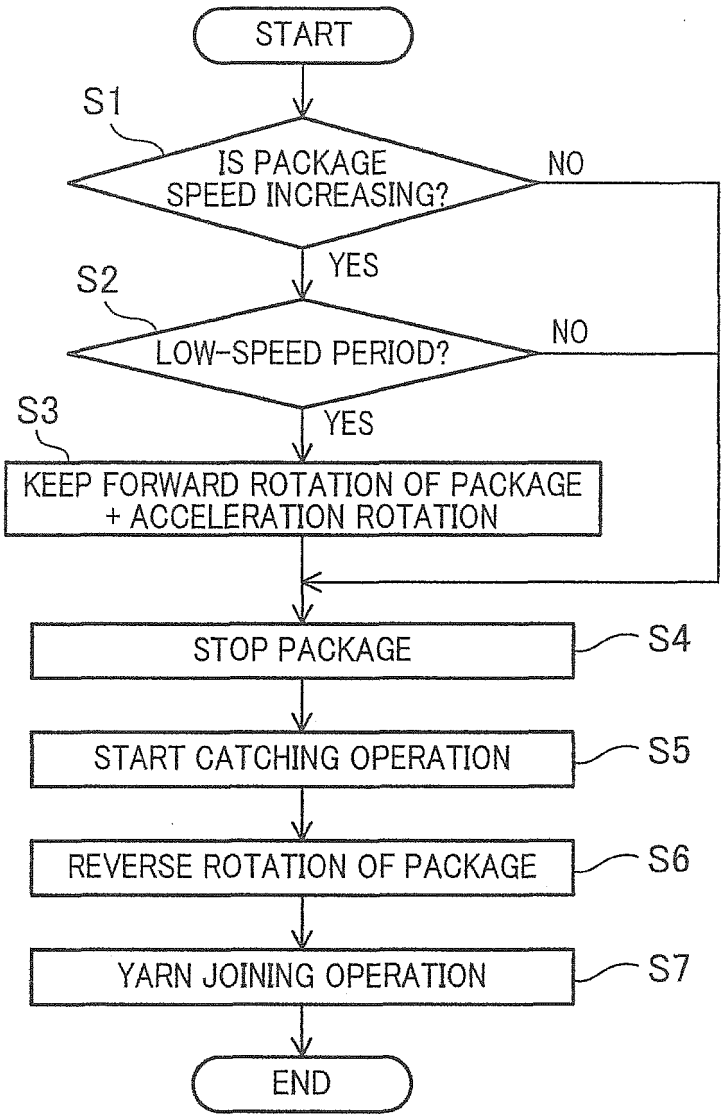

START
S1
IS PACKAGE SPEED INCREASING?
NO
YES
S2
LOW-SPEED PERIOD?
NO
YES
S3
KEEP FORWARD ROTATION OF PACKAGE + ACCELERATION ROTATION
STOP PACKAGE
S4
START CATCHING OPERATION
S5
REVERSE ROTATION OF PACKAGE
S6
YARN JOINING OPERATION
S7
END

FIG.5

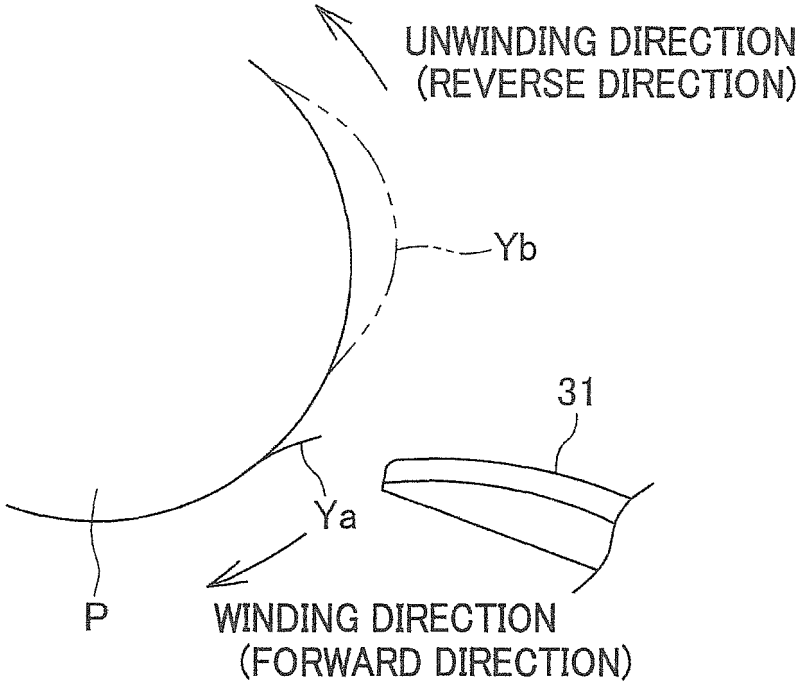
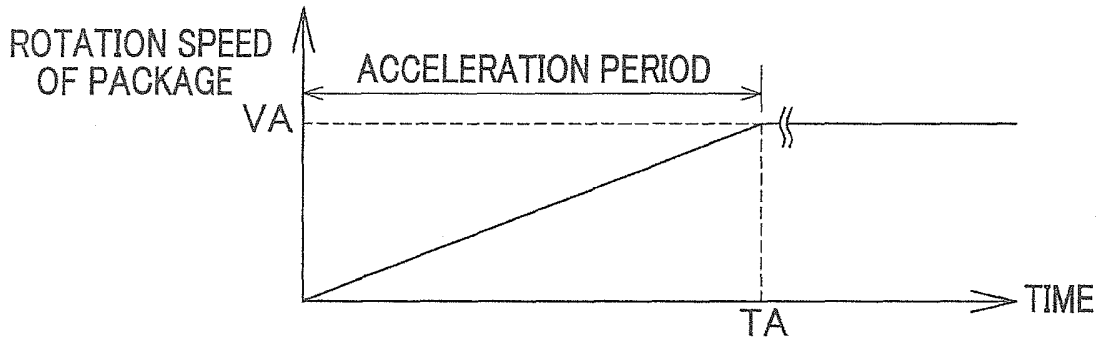
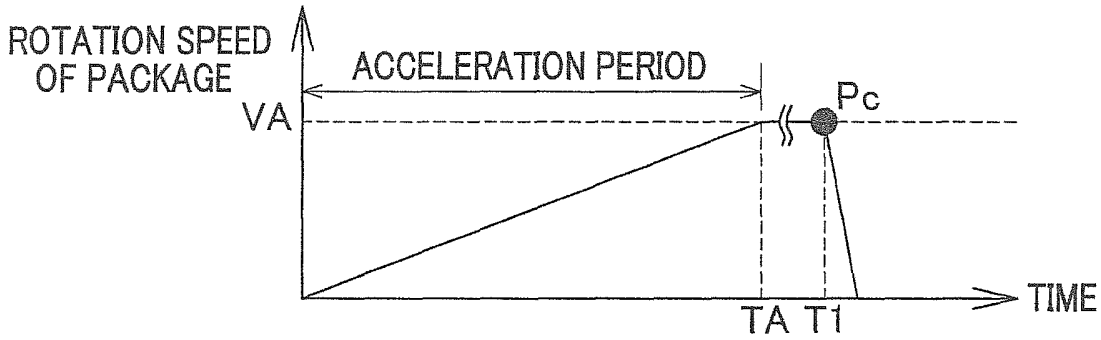

UNWINDING DIRECTION
(REVERSE DIRECTION)
Yb
31
Ya
P
WINDING DIRECTION
(FORWARD DIRECTION)

FIG.6

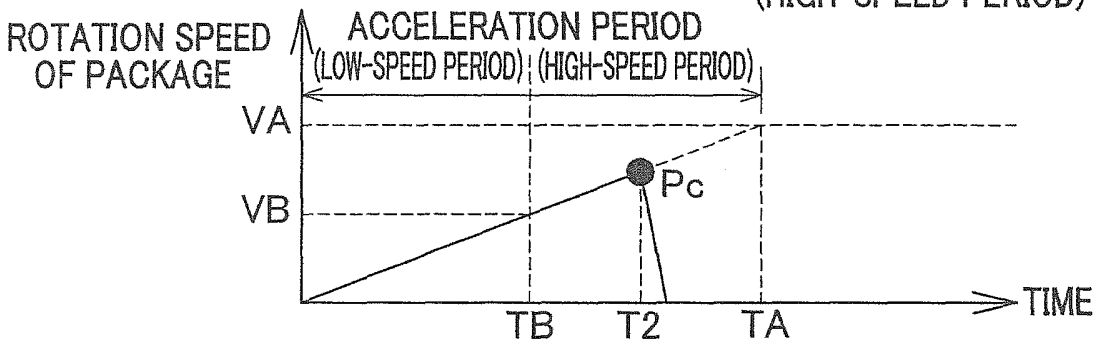
(a) NORMAL WINDING PROCESS



(b) YARN BREAKAGE OCCURS DURING NORMAL WINDING PERIOD



(c) YARN BREAKAGE OCCURS DURING ACCELERATION PERIOD (HIGH-SPEED PERIOD)



(d) YARN BREAKAGE OCCURS DURING ACCELERATION PERIOD (LOW-SPEED PERIOD)

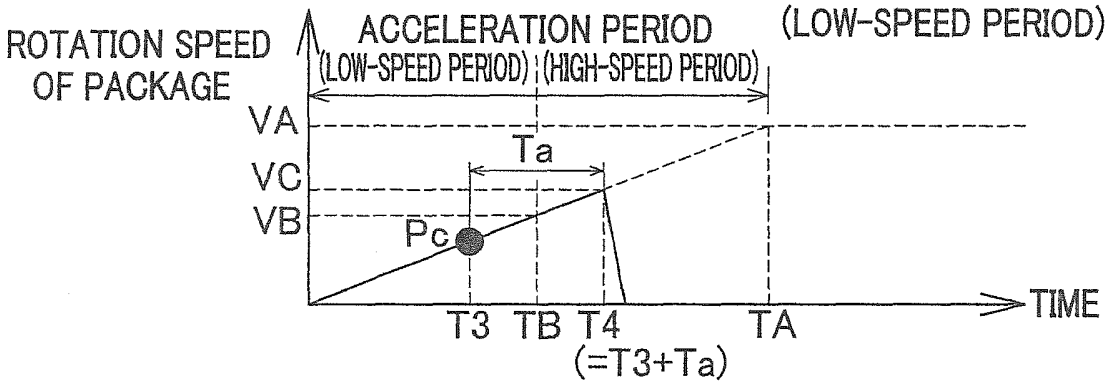


FIG.7

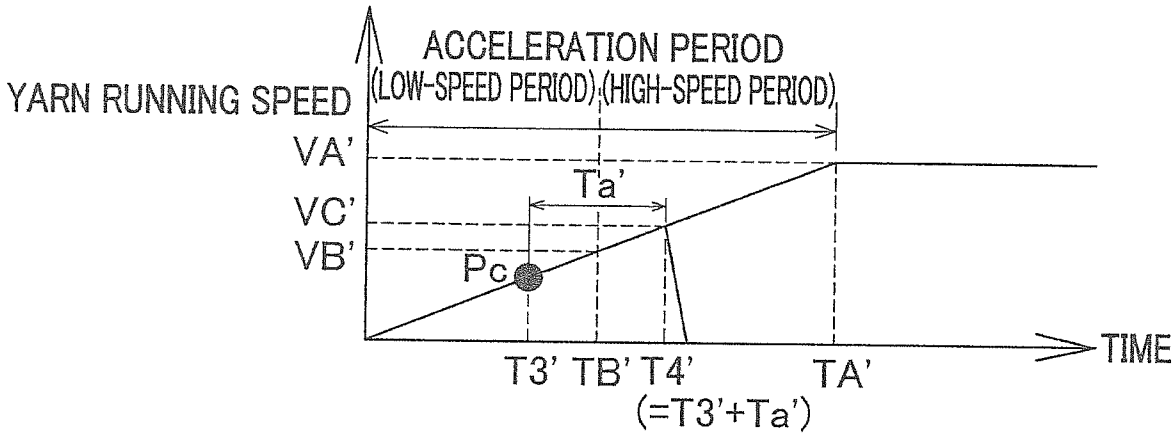
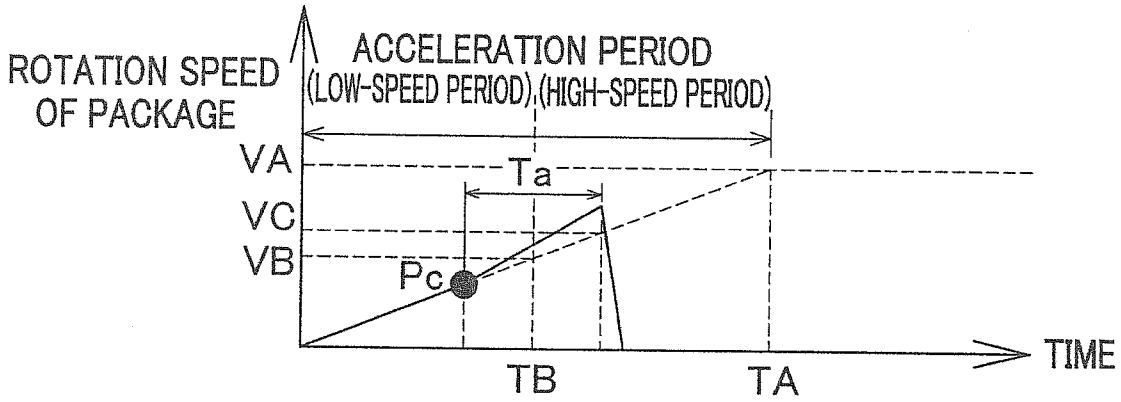

ACCELERATION PERIOD
(LOW-SPEED PERIOD)
(HIGH-SPEED PERIOD)
YARN RUNNING SPEED
VA'
Ta'
VC'
VB'
Pc
TIME
T3' TB' T4'
(=T3'+Ta')
TA'

FIG.8

(a)


ACCELERATION PERIOD
(LOW-SPEED PERIOD)
(HIGH-SPEED PERIOD)
ROTATION SPEED
OF PACKAGE
VA
Ta
VC
VB
Pc
TIME
TB
TA

(b)

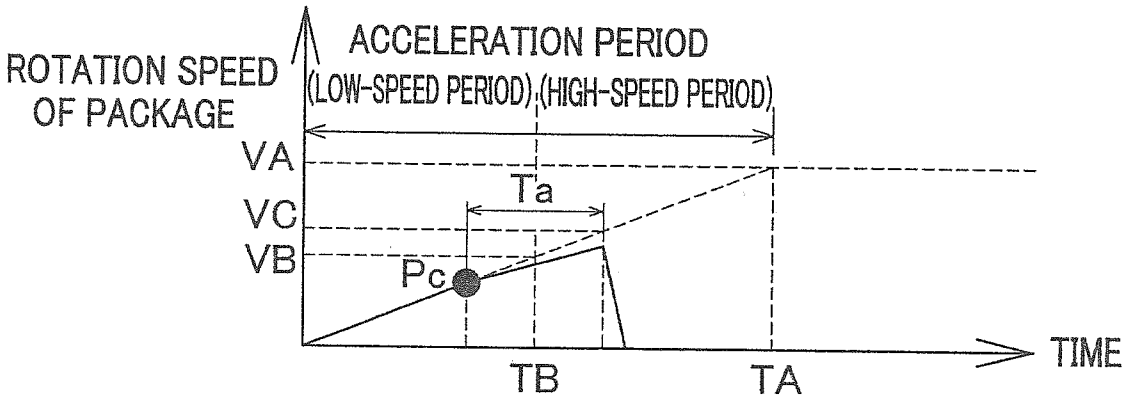

ACCELERATION PERIOD
(LOW-SPEED PERIOD)
(HIGH-SPEED PERIOD)
ROTATION SPEED
OF PACKAGE
VA
Ta
VC
VB
Pc
TIME
TB
TA

FIG.9

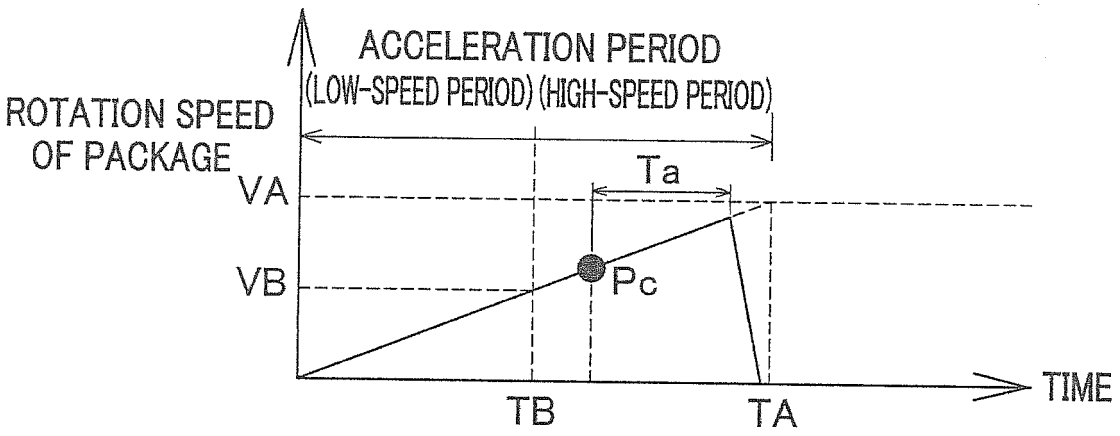
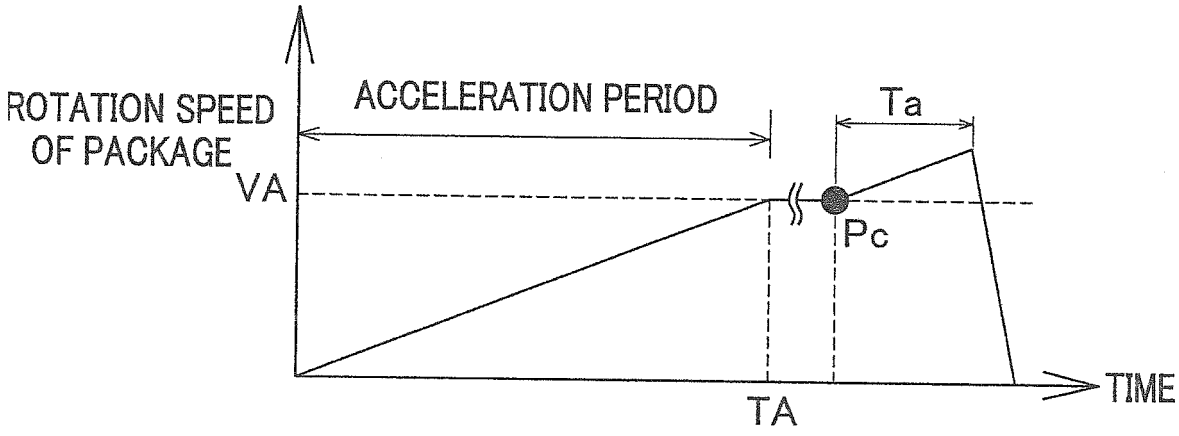

ACCELERATION PERIOD
(LOW-SPEED PERIOD) (HIGH-SPEED PERIOD)
ROTATION SPEED OF PACKAGE
Ta
VA
VB
Pc
TIME
TB
TA

FIG.10


ROTATION SPEED OF PACKAGE
ACCELERATION PERIOD
Ta
VA
Pc
TIME
TA

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/055350

A. CLASSIFICATION OF SUBJECT MATTER
B65H67/08(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65H67/00-69/00, D01H15/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 24919/1990(Laid-open No. 116354/1991) (Murata Machinery Ltd.), 02 December 1991 (02.12.1991), specification, page 8, line 5 to the last line; fig. 2 (Family: none)	1-17
A	JP 54-24026 B2 (Toray Industries, Inc.), 17 August 1979 (17.08.1979), column 3, 5th line from the bottom to column 4, 6th line from the bottom; fig. 1 (Family: none)	1-17

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 May 2015 (08.05.15)	26 May 2015 (26.05.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007302457 A **[0005]**